CROSSINGS

NEWSLETTER OF THE WOOD IN TRANSPORTATION PROGRAM

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In This Issue

Assessment of the Environmental Effects Associated With Wooden Bridges Preserved With Creosote, Pentachlorophenol, or Chromated Copper Arsenate

In 1997, the USDA Forest Service's Forest Products Laboratory in conjunction with the Federal Highway Administration contracted with Oregon State University and Aquatic Environmental Sciences to conduct a three-phase study (contract RJVA-2828).

The purposes of this study were to:

1. assess the environmental response associated with existing timber bridges,
2. determine the loss of various types of preservatives from overhead bridge structures, and
3. develop a computer model to assist in the understanding of site-specific environmental risks associated with proposed timber bridge construction.

The author of the report is Kenneth M. Brooks, Owner and Principal Scientist, Aquatic Environmental Sciences, Port Townsend, Washington.

Following is the abstract from the 100-page report that resulted from this study.

Timber bridges provide an economical alternative to concrete and steel structures, particularly in rural areas with light to moderate

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vehicle traffic. Wooden components of these bridges are treated with chromated copper arsenate type C (CCA), pentachlorophenol, or creosote to prolong the life of the structure from a few years to many decades. This results in reduced transportation infrastructure costs and increased public safety. However, the preservative used to treat the wooden components in timber bridges is lost to the environment in small amounts over time. This report describes the concentration of wood preservatives lost to adjacent environments and the biological response to these preservatives as environmental contaminants. Six bridges from various states were examined for risk assessment: two creosote-treated bridges, two pentachlorophenol-treated bridges, and two CCA-treated bridges. In all cases, the largest bridges located in biologically active environments associated with slow-flowing water were selected to represent worst-case analyses.

Sediment and water column concentrations of preservative were analyzed upstream from, under, and downstream from each bridge. The observed levels of contaminant were compared with available regulatory standards or benchmarks and with the quantitative description of the aquatic invertebrate community sampled from vegetation and sediments. Pentachlorophenol- and creosote-derived polycyclic aromatic hydrocarbons (PAHs) were not observed in the water near any of the selected bridges. However, low levels of PAHs were observed in the sediments under and immediately downstream from these bridges. Pentachlorophenol concentrations did not approach toxicological benchmarks. Sediment concentrations of naphthalene, acenaphthylene, and phenanthrene exceeded the probable effect level. Metal levels at the bridges treated with CCA were less than predicted effect levels, in spite of questionable construction practices. Adverse biological effects were not observed in the aquatic invertebrate community or laboratory bioassays conducted on water and sediments sampled at each of the bridges. Results of this study reveal the need to follow the construction information found in Best Management Practices for the Use of Treated Wood In Aquatic Environments published by Western Wood Preservers Institute.

Regulatory benchmarks used in risk assessments of this type need to be indexed to local environmental conditions. The robust invertebrate communities associated with slow-moving streams over soft bottoms were not susceptible to the concentrations of PAHs that would be expected to affect more sensitive taxa, which typically are located in faster moving water over hard bottoms. Contaminants released from timber bridges into these faster systems (where more sensitive taxa are located) are significantly diluted and not found at biologically significant levels.

To obtain a copy of this report, please contact the National Wood In Transportation Information Center at 304-285-1591 and request publication number *WIT-05-0023* or visit the Wood In Transportation website at www.fs.fed.us/wit; click on "New Publications Available".

8th National Timber Bridge Design Competition Results Announced

Eleven teams of students from ten universities across the United States matched wits to devise a better way to "cross the creek" during the 8th National Timber Bridge Design Competition. Open to student chapters of American Society of Civil Engineers (ASCE) and Forest Products Society (FPS), the competition was made possible by a grant from the USDA Forest Service, Wood In Transportation Program. The Southern Pine Council of the Southern Forest Products Association, Unit Structures LLC, and Willamette Industries provided additional financial support. Southwest Mississippi Resource Conservation and Development (RC&D), Inc., coordinated the competition, and the Civil Engineering Department at Mississippi State University provided technical assistance.

Each team designed, constructed, and tested their bridges on their home campus, then submitted documentation of their activities and results to a panel of judges for review. The competition was conducted online via the Internet. Each team was required to

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post design drawings, test results, and project highlights on the Internet at www.msrcd.org. To view details of competition results and to access each entry in its entirety, go to www.msrcd.org; when the map of Mississippi appears, click on "SW", choose the "National Timber Design Competition," and click on "2000 Competition Results."

Winner of the **Best Overall Design Award** sponsored by Willamette Industries was **Virginia Tech Forest Products Society**. Their design featured a pair of longitudinal glulam beams supporting a transverse deck of ¾-inch CCA-treated southern pine (SP), each centered over transverse floor beams of 2-inch by 4-inch SP, essentially forming a continuous series of transverse T-beams. In turn, two tapering, glued-laminated, yellow poplar arches supported the entire structure. Both the arches and the longitudinal stringers incorporated carbon fiber strips between laminations in regions of highest tension forces. The bridge used no metal fasteners, only resorcinol/phenol formaldehyde adhesive, carbon fiber and wood. This entry also placed **first** in **Best Support Structure, Best Deck,** and **Most Innovative Design**.

San Francisco State University's ASCE chapter was the **second highest prize winner**, capturing **second place** in **Best Overall Design and Best Support Structure** and **third** in **Most Aesthetic Design** and **Most Innovative Design** with their built-up laminated arch structure.

Other award winning teams were :

- Clarkson University ASCE
  Practical Design
  3rd—Best Deck
- California State-Fresno
  1st—Most Aesthetic Design
- Lawrence Technological University ASCE
  3rd —Best Support Structure
- Washington University of St. Louis ASCE
  3rd— Most Practical
- Merrimack College ASCE
  2nd— Best Deck
- University of North Carolina at Charlotte ASCE Team 2
  2nd—Most Innovative
- Oregon State University ASCE
  2nd—Most Aesthetic
  3rd—Best Design.

Also competing were University of Louisiana at Lafayette ASCE and University of North Carolina ASCE Team 1.

Rules for the 2001 competition are posted at www.msrcd.org (follow links as previously instructed). For additional information, contact Southwest Mississippi RC&D, Inc., competition coordinators at southwest@msrcd.org.

The competition's objectives are to promote interest in the use of wood as a bridge construction material, to generate innovative and cost-effective timber bridge design techniques, and to develop an appreciation of the engineering capabilities of wood among future transportation and forest products engineers. Following the competition, most of the bridges were placed into actual use on campus walkways, golf courses, cross-country tracks, park trails, etc.

The test bridges were 10.8 feet long and 4.6 feet wide and were loaded with a test weight of approximately 4,500 pounds. Average weight of the bridge models was 548 pounds. At full loading, maximum bridge deflection ranged from .055 inch to .191 inch. Maximum allowable deflection was .31 inch. Net deck deflection for the nine bridges that met the maximum allowable deflection of deck span divided by 400 averaged 45 percent of maximum allowable. Percent non-wood materials in the bridges averaged 9 percent; maximum percent non-wood materials allowed was 25 percent by weight. A total of 98 students spent 4,930 hours on the competition, competing for $10,000 in prizes. Judges were Greg Jones, Willamette Industries; Dr. Ralph Sinno, Mississippi State University; and Marshall McLaughlin, USDA Natural Resources Conservation Service.

— **Bennie Hutchins**
Competition Coordinator
Southwest Mississippi RC&D

Second International Conference on Advanced Engineered Wood Composites

The Second International Conference on Advanced Engineered Wood Composites (AEWCs) will be held from August 14-16, 2001, at the Grand Summit Resort Hotel & Conference Center-Sunday River, near Bethel, Maine. The First International Conference, held in Bar Harbor, Maine, in 1999, was attended by over 150 people from seven countries.

The upcoming conference will provide a focused venue for presenting and discussing the commercial, scientific, and engineering aspects of AEWCs. These composites, which combine wood with fiber-reinforced polymers (FRPs), represent an important industrial segment with a unique set of issues. A combination of industrial researchers, business-development specialists, structural engineers, and materials researchers will gather in a setting designed to create valuable and necessary interactions among all interested parties.

Papers and poster presentations are being solicited in the following areas:

- market-development case studies,
- durability,
- structural performance,
- processing,
- extruded composites,
- reinforced composites (both laminated and integral reinforcements),
- code implementation,
- alternative technologies,
- engineered wood composites,
- building systems,
- bridge systems,
- automotive applications.

Proceedings of the papers will be available at the conference. In addition, a workshop covering processing and design fundamentals of wood/FRP hybrid composites will be offered to assist interested parties in becoming more familiar with this important and expanding materials area.

For further information, contact: Ms. Doreen Parent, 793 AEWC Bldg., University of Maine, Orono, ME 04469-5793; Telephone: (207) 581-2123; Fax: (207) 581-2074; E-mail: contactaewc@umit.maine.edu; AEWC Website Address: http://www.aewc.umaine.edu.

Role of Construction Debris in Release of Copper, Chromium, and Arsenic From Treated Wood Structures

Recent research on the release of wood preservatives from treated wood used in sensitive environments has not considered the potential contribution from construction residues. This study sought to develop leaching rate data for small construction debris and compare those to the release rate from treated wood itself. Western hemlock boards were pressure treated with chromated copper arsenate-Type C (CCA-C), and then common construction tools were used to generate sawdust or shavings from those boards. These wood particles were then leached in deionized water, and the leaching rate was compared with that of solid wood samples cut form the same specimen. Released rate data from this study were also compared with those from end-matched samples that were leached in artificial rain in an earlier study. The release rates of copper, chromium, and arsenic from CCA-C treated chainsaw sawdust, circular saw sawdust, and spade bit shavings were many times higher than from solid wood when samples were immersed in water. There was little difference in the release rates among the three types of shavings and sawdust, despite differences in their particle sizes. The rates of release from decking exposed to rainfall were many times lower than that of construction debris or solid wood continually immersed in water. These results show the importance of minimizing the amount of construction debris that is allowed to enter the aquatic environment. However, example calculations also demonstrate that if reasonable efforts are made to minimize release of construction debris, the contribution of these particles to the overall release of preservative from the structure well be minimal.

To obtain a copy, please contact the National Wood In Transportation Information Center at 304-285-1591 and request publication number *WIT-05-0024* or visit the Wood In Transportation website at www.fs.fed.us/wit; click on "New Publications Available".

NEW PUBLICATIONS

Distribution of Borates Around Point Source Injections in Wood Members Exposed Outside

In bridge timbers, wood decay is usually found where water has accessed the end-grain surfaces. In preservative-treated members, end-grain surfaces are most likely to be those resulting from on-site framing cuts or borings. Because these at-risk surfaces are easy to see, it seems feasible to establish a program where diffusible preservatives are repetitively inserted into these critical areas spatially distributed in a grid and on a schedule that will ensure protection, thereby extending the life of the entire structure. The objective of this study was to determine the vertical and lateral distribution and the post-treatment behavior of injected and inserted borate preservatives in wood exposed to natural wetting in field exposure. During this 1- and 2-year exposure, rain wetting elevated the moisture content of the wood enough to support growth of decay fungi in wood not protected by borates. Point source treatments consisted of either borate solutions or fused borate rods that were injected or inserted, respectively, into predrilled holes. The longitudinal movement of borates applied as either glycol or aqueous solutions was generally greater than that occurring with treatment of borate rods only. Lateral distribution of borates was similar among treatments. In southern pine, differences in both vertical and longitudinal movement of borate from the insertion holes were associated with the type of closure used. Results indicate that borates can be included in a maintenance program consisting of time-sequenced treatment of critical regions of wood bridges that are at risk for internal decay. Grids for placement of point sources of diffusible borates in engineered wood structures could be developed on a wood-species-specific basis. Such treatments would complement the exterior shell of protection provided by the original pressure treatment and enhance long-term durability.

To obtain a copy, please contact the National Wood In Transportation Information Center at 304-285-1591 and request publication number *WIT-06-0021* or visit the Wood In Transportation website at www.fs.fed.us/wit; click on "New Publications Available".

Field Performance of Timber Bridges 18. Byron Stress-Laminated Truss Bridge

The Bryon bridge was constructed in the fall of 1993 in Bryon, Maine. The bridge is a single-span, two-lane, stress-laminated truss structure that is approximately 46 feet long and 32 feet wide. The truss laminations were produced using chromated copper arsenate (CCA) treated southern pine connected with metal plate connectors. This report includes information on the design, construction, and field performance of the bridge. Field performance was monitored for approximately five years, beginning shortly after bridge construction. Performance monitoring involved collecting and evaluating data relative to wood moisture content, force level of stressing bars, behavior under static truck loading, and overall structural condition. The field evaluations showed that the Byron bridge is performing well, with no structural or serviceability deficiencies.

To obtain a copy, please contact the National Wood In Transportation Information Center at 304-285-1591 and request publication number *WIT-06-0038* or visit the Wood In Transportation website at www.fs.fed.us/wit; click on "New Publications Available".

Guidelines for Design, Installation, and Maintenance of a Waterproof Wearing Surface for Timber Bridge Decks

To enhance long-term timber bridge performance, timber material must be protected from moisture. Wearing surfaces made of asphalt pavement with and without a waterproof membrane have been used to provide protection from moisture on timber decks. This type of wearing surface also protects the deck from other damage while providing a smooth, skid-resistant surface. However, the long-term performance of timber bridges has often not been satisfactory as a result of cracking of the wearing surface or separation of the asphalt or membrane from the deck. Cracking or separation allows moisture migration to the timber deck and decreases ride quality. To improve the performance of a wearing surface, it must be designed, installed, and maintained properly. This document provides guidelines for the proper design, installation, and maintenance of a waterproof wearing surface for timber bridge decks. The design section includes material descriptions and asphalt mixture reccommendations. The installatin section presents material testing, field inspection, detailed drawings, and errors to avoid. The maintenance section explains the typical signs of distress and corrective procedures.

To obtain a copy, please contact the National Wood In Transportation Information Center at 304-285-1591 and request publication number *WIT-12-0002*.

Field Performance of Timber Bridges 20. Gray Stress-Laminated Deck Bridge

The Gray bridge was constructed in the fall of 1991 in Gray, Maine. The bridge is a single-span, two-lane, stress-laminated deck structure that is approximately 24 feet long and 23 feet wide. It was constructed from chromated copper arsenate (CCA) treated eastern hemlock grown in Maine. This report presents information on the design, construction, and field performance of this bridge. Field performance of the bridge was monitored for 6-1/2 years, beginning shortly after construction. During the field monitoring program, data were collected relative to wood moisture content, force level of stressing bars, behavior under static truck loading, and overall structural condition. With the exception of having to be retensioned approximately every 3 years, the bridge is performing well, with no structural or serviceability deficiencies.

To obtain a copy, please contact the National Wood In Transportation Information Center at 304-285-1591 and request publication number *WIT-06-0040* or visit the Wood In Transportation website at www.fs.fed.us/wit; click on "New Publications Available".

Article contributions, questions or comments may be sent to Ed Cesa, Program Coordinator, National Wood In Transportation Information Center or Mr. Chris Grant, Program Assistant, USDA Forest Service, 180 Canfield Street, Morgantown, WV 26505; Phone: 304-285-1591; FAX: 304-285-1587, E-mail to cgrant@fs.fed.us or website at *www.fs.fed.us/na/wit*.

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